MEICHEN SONG

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# EDUCATION

**Department of Applied Mathematics and Statistics, Stony Brook University Stony Brook, NY, US**

Ph.D. in Statistics, advised by Prof. Jiaqiao Hu **Sept. 2019 – Jun. 2025**

Top 1 in Qualifying Exam

**School of Mathematics, Southeast University Nanjing, China** Bachelor of Science in Statistics, Financial Statistics Concentration **Sept. 2015 - Jun. 2019** Ranking: 2/36 (Top 5%)

# RESEARCH INTEREST

* Risk-based simulation optimization, Bayesian risk optimization, BRO-based formulations of Markov Decision Processes and reinforcement learning, multi-agent reinforcement learning

# PUBLICATIONS

* J. Hu, **M. Song**, Michael C. Fu, 2024. *Quantile Optimization via Multiple Timescale Local Search for Black-box Functions.* Operations Research. DOI: [10.1287/opre.2022.0534](https://doi.org/10.1287/opre.2022.0534)
* J. Hu, **M. Song,** Michael C. Fu, Yijie Peng, 2024. *Simulation Optimization of Conditional Value-at-Risk.* IISE Transactions. Accepted on Nov. 3rd, 2024.
* **M. Song,** J. Hu,Michael C. Fu, 2024, December. *Simultaneous Perturbation-Based Stochastic Approximation for Quantile Optimization.* 2023 Winter Simulation Conference (WSC) (pp. 3565-3576). IEEE.
  + Best Contributed Theoretical Paper - Finalist and presented an oral presentation.

DOI: [10.1109/WSC60868.2023.10408706](https://doi.org/10.1109/WSC60868.2023.10408706)

* **M.** **Song**, et al., 2023. *Differentiable Arbitrating in Zero-sum Markov Games.* Proceedings of 22nd International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2023. Acceptance rate: 23.3%).
  + Presented an oral presentation. DOI:<https://dl.acm.org/doi/10.5555/3545946.3598743>
* D. Liang, **M. Song**, et al., 2021 *Supervised machine learning approach to molecular dynamics forecast of SARS-CoV-2 spike glycoproteins at varying temperatures.* MRS advances, 6, pp.362-367.DOI: <https://doi.org/10.1557/s43580-021-00021-4>
* **M. Song,** et al., 2020. *Long-Time Simulation of Temperature-Varying Conformations of SARS-CoV-2 Spike Glycoprotein on IBM Supercomputers.* Research Poster, Supercomputing 2020 (SC20). URL: <https://sc20.supercomputing.org/proceedings/tech_poster/tech_poster_pages/rpost124.html>
* X. Zhao, **M. Song**, et al., 2020. *Data-Driven Temporal-Spatial Model for the Prediction of AQI in Nanjing*. Journal of Artificial Intelligence and Soft Computing Research, *10*(4), pp.255-270. DOI:  <https://doi.org/10.2478/jaiscr-2020-0017>

# WORKING PAPERS

* **M. Song,** et al., *Discrete Global Quantile Optimization via Regularized Adaptive Annealing Search for Black-box Functions.* 
  + Working on paper writing.

# RESEARCH EXPERIENCE

## Bayesian Risk Optimization Aug. 2025 – Present

*Groseclose Postdoctoral Fellow* Atlanta, GA, US

## Advisor Prof. Enlu Zhou

## Episodic Bayesian Risk Averse RL

## Simulation-based Optimization for Black-box Systems Jan. 2021 – Present

*Research Assistant* Stony Brook, NY, US

## Advisor: Prof. Jiaqiao Hu

## Quantile Optimization via Local Search

## Focused on quantile-based simulation optimization (SO) and proposed three iterative multi-timescale local search algorithms.

## Employed the simultaneous-perturbation-based gradient estimator to estimate the descent directions. It requires only three evaluations per iteration regardless of the problem's dimensionality.

## Derived the finite-time convergence rate and illustrated the performance of the method on heavy-tailed and high-dimensional problems.

## Global Quantile Optimization via Random Search

## Considered quantile optimization of black-box functions that are estimated with noises.

## Proposed a stochastic adaptive search algorithm that optimizes the quantile function of simulation output while approximating the quantile function.

## Analyzed the performance of the algorithm in terms of both accuracy and sample efficiency of the novel search structure theoretically and empirically. Derived and compared the finite-time convergence rate of proposed search structure with the pure random search method.

## Simulation Optimization of Conditional Value at Risk (CVaR)

## Considered simulation optimization problems with CVaR as the performance measure.

## Derived an analytical expression for CVaR gradient and proposed a gradient estimator that only requires two evaluations without requiring knowledge of the simulation model.

## Designed a two-timescale algorithm, derived its convergence guarantee and convergence rate, and compared it with an algorithm based the likelihood ratio approach that requires the p.d.f. of simulation output.

## Incentivized Multi-agent Reinforcement Learning May 2021 – Jul. 2022

*Research Assistant, Shanghai Qi Zhi Institute (research center jointly hosted by Institute for Interdisciplinary Information Sciences at Tsinghua University and Shanghai government)* Shanghai China

## Advisor: Prof. Yi Wu (Tsinghua University)

## Nash Equilibrium (NE) Refinement in Multi-agent Reinforcement Learning

## Initiated the study of NE refinement by perturbing the reward function in a zero-sum Markov game.

## Formulated a bi-level optimization. The lower level involves solving the NE for a given reward function, which makes the overall problem challenging for end-to-end optimization.

## Developed a backpropagation scheme that can differentiate through the NE. It provides the gradient feedback for the upper-level optimization. It only requires a black-box solver for the (regularized) NE.

## Proved the sub-linear convergence rate for the bi-level optimization scheme in multi-agent reinforcement learning.

## Molecular Dynamics Simulation on Supercomputing Apr. 2020 - Dec. 2020

*Research Assistant* Stony Brook, NY, US

Advisor: Prof. Yuefan Deng

## In-silico Analysis of the Thermo and Conformational States of SARS-CoV-2

* + Conducted the microsecond-scale simulations of the S-protein on the supercomputers and revealed the S-protein’s conformational changes at several temperatures, identifying the critical temperature.

## Applications of Machine Learning Nov. 2016 - May 2020

*Research Assistant* Nanjing, China

Advisor: Prof. Xuan Zhao

## Temporal and Spatial Prediction of AQI via Data-driven Model

## Developed a temporal-based classifier using an improved KNN algorithm to forecast the AQI in monitored areas.

## Developed a spatial-based classifier using a BP neural network algorithm to estimate the air quality of non-monitoring area by analyzing the main spatial influencing factors.

## Constructed a temporal-spatial model to predict AQI in a non-monitoring area.

# TEACHING EXPERIENCE

## Instructor for the Survey of Probability and Statistics (AMS310) May – Jul. 2022-2024

## Instructor for the recitations in:

## Introduction to Mathematical Statistics (AMS570) Jan. 2022 – May 2022, Jan. 2021 – May 2021

## Applied Calculus III (Multivariable Calculus) (AMS261) Aug. 2021 – Dec. 2021

## Applied Calculus IV Differential Equations (AMS361) Aug. 2020 – Dec. 2020

## Teaching assistant:

## Data Analysis (AMS572) Aug. 2022 – Dec. 2022

## Probability and Statistics in the Life Science (AMS110) Jan. 2020 – May. 2020

## Probability Theory (AMS311) Aug. 2019 – Dec. 2019

# WORK EXPERIENCE

## School of Industrial and Systems Engineering at the Georgia Institute of Technology Aug. 2025 - Present

*Groseclose Postdoctoral Fellow* Atlanta, GA, USA

## Developing efficient simulation optimization methods for solving Bayesian Risk Optimization (BRO) and BRO-based formulations of Markov Decision Processes and reinforcement learning

## Guidewire Navigation in Medical Surgeries Jul. 2022 - Sep. 2022

*Research Intern, Angio8* Shenzhen, China

## Implemented a 3D U-net distilled from SAM to segment and reconstruct coronary arteries from CT scans.

## Built the simulation environment that can interact with reinforcement learning (RL) algorithms.

## Designed and trained an RL algorithm to navigate the guidewire delivery in the simulated PCI environment.

# TECHNICAL SKILLS

* MATLAB, R, Python, C++.